



Regular article

The brewery wastewater treatment and membrane fouling mitigation strategies in anaerobic baffled anaerobic/aerobic membrane bioreactor



Jiadong Liu^{a,b,*}, Chang Tian^{a,b}, Xiaolan Jia^{a,b}, Jingxue Xiong^{a,b}, Shaonan Dong^{a,b}, Lei Wang^{a,b}, Longli Bo^{a,b}

^a School of Environmental & Municipal Engineering, Xi'an University of Architecture and Technology, Xi'an 710055, China

^b Key Laboratory of Membrane Separation of Shaanxi Province, Xi'an University of Architecture and Technology, Xi'an 710055, China

ARTICLE INFO

Article history:

Received 19 March 2017

Received in revised form 14 July 2017

Accepted 19 July 2017

Available online 4 August 2017

Keywords:

AnMBR

MBR

Sediment MFC

Hydraulic retention time

Energy consumption

ABSTRACT

In this study, the anaerobic baffled reactor contained sediment microbial fuel cell (MFC) was combined with anaerobic/aerobic membrane bioreactor (AnMBR/MBR). The brewery wastewater treatment and membrane fouling mitigation strategies were studied comprehensively. During anaerobic treatment process in this study, the chemical oxygen demand (COD) removal ratio of brewery wastewater could be maintained at 73.87% when the hydraulic retention time (HRT) was reduced from 42.44 h to 22.60 h. For membrane fouling mitigation in AnMBR, regular aeration was more effective than back flush, and the fouling could be inhibited further when both controlling ways were adopted at the same time. For membrane fouling mitigation in AnMBR of this study, only 0.52%–0.99% of electric energy was required for fouling mitigation, but 31.80% of energy was needed in MBR.

© 2017 Elsevier B.V. All rights reserved.

1. Introduction

Membrane bioreactor (MBR) has been studied comprehensively for wastewater treatment and membrane fouling mitigation [1]. As the MBR could replace the sedimentation tank, separate the sludge retention time (SRT) and hydraulic retention time (HRT) and enhance the wastewater treatment efficiency, which has been introduced into anaerobic treatment system as anaerobic membrane bioreactor (AnMBR) [2]. Comparing with traditional anaerobic treatment system, AnMBR could maintain the activated sludge and enhance the properties of effluent, but it is hard to be applied in practice at the present stage because of its serious membrane fouling [2].

For the MBR and AnMBR, the wastewater treatment efficiency and membrane fouling mitigation have been considered as the key points during the research and practical application [1,2]. Previous report indicated that the gel layer rather than cake layer caused more serious membrane fouling in MBR, because of the much higher attractive interaction energy of gelling foulant-membrane

combination [3]. In AnMBR, the cake layer structure is one of the major factors governing membrane fouling [4]. But the operation conditions, including hydraulic retention time (HRT) [5,6], temperature [7], structure of reactor and additive [8], would affect the wastewater treatment efficiency and membrane fouling obviously. Results indicated that shorter HRT promoted microorganism growth and soluble microbial products (SMP) accumulation, which caused more serious membrane fouling [6]. Lower temperature would cause higher chemical oxygen demand (COD) and SMP, lower particle size, and higher turbidity in the supernatant and result in faster membrane fouling [7]. Granular activated carbon was added into AnMBRs to adsorb SMP, which could reduce organic fouling, enhance membrane flux and wastewater treatment efficiency [8] and it also could inhibit membrane fouling by the fluidization [9]. The AnMBR also was combined with other treatment process such as microbial fuel cells (MFCs) for efficiency enhancement in wastewater treatment, membrane fouling mitigation and energy recovery [10–12].

Actually, the removal efficiency of pollutants in wastewater would affect the membrane fouling condition in MBR or AnMBR [8]. Because those water contaminants and membrane foulants, such as suspended solid, humus, protein and polysaccharide in influent or generated by microorganisms could cause membrane fouling directly as the result of pore blocking and filter cake for-

* Corresponding author at: School of Environmental & Municipal Engineering, Xi'an University of Architecture and Technology, Xi'an 710055, China.

E-mail addresses: liujiadong@xauat.edu.cn, liujiadong@hotmail.com (J. Liu).

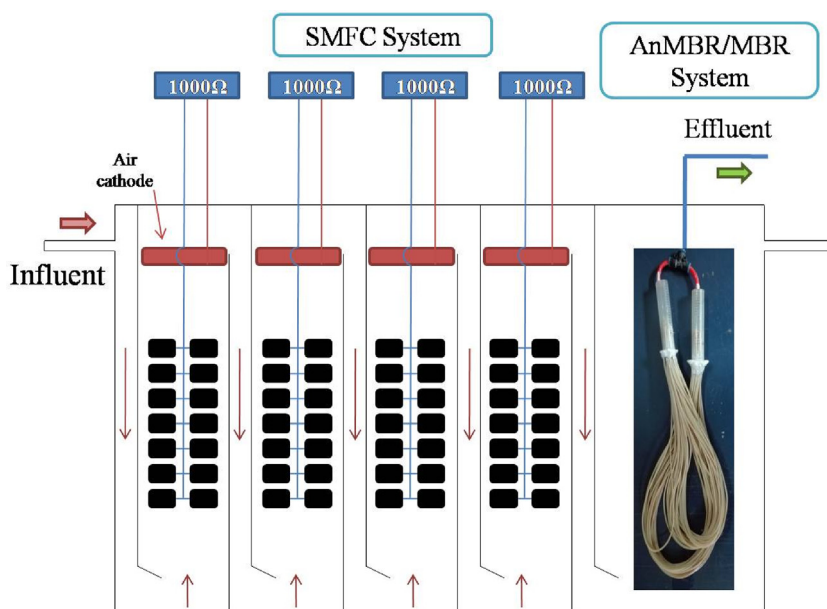


Fig. 1. The schematic diagram of anaerobic baffled-anaerobic/aerobic membrane bioreactor.

mation [2]. Some of the membrane fouling mitigation strategies also could enhance the wastewater treatment efficiency. The liquid circulation, air or biogas aeration in MBR or AnMBR could promote the mass transfer rate of contaminants to microorganisms [9,13], except for turbulence enhancement [14]. The addition of media/filler [15] and activated carbon [8] could enhance the stability and shock-resistant ability of aerobic or anaerobic activated sludge, which also could polish the membrane surface and adsorb the foulants for membrane fouling control at the same time [8,9]. In other words, the wastewater treatment process is the same process of membrane foulants removal or fouling mitigation.

The path length of the wastewater in the anaerobic baffled reactor (ABR) could be extended and the activated sludge could be precipitated from supernatant, which is conducive to wastewater treatment. The supernatant with less membrane foulants also could benefit membrane fouling mitigation when the membrane separation was combined with ABR [16]. Previous report showed that the anaerobic baffled membrane bioreactor (ABMBR) could balance the wastewater treatment and membrane fouling mitigation at the same time [16]. But previous reports also indicated that the effluent from AnMBR was smelly and with high concentration of chemical oxygen demand (COD) [17,18]. And there were three problems have not been solved during our previous study [16], 1) high concentration wastewater should be treated in AnMBR, 2) the properties of effluent were not good enough for the membrane separation process, 3) the energy recovery was not considered because of low strength influent was used.

So in this study, the brewery wastewater with higher COD was used as influent. The different operating conditions, including variation of HRT, addition of filler and optimization of membrane cleaning strategies, were studied to identify the potential of membrane fouling mitigation and wastewater treatment efficiency. To take advantage of the reactor structure, the sediment microbial fuel cells (MFCs) were combined with anaerobic baffled processes for energy recovery. In ABR, the wastewater crossed through the whole anode/filler from the bottom up for generation of electrons and degradation of organic matters, and then the oxygen was reduced by those generated electrons for power output on floating cathode on the top of ABR. In order to meet different discharge standards, the aerobic MBR was operated to enhance the effluent properties at the last operating cycle. The water property parameters of influ-

ent, supernatant in anaerobic baffled processes and effluent were monitored during the whole experiment. The membrane fouling and power output conditions were monitored constantly.

2. Materials and methods

The reactor and hollow fiber polyvinylidene fluoride (PVDF) membrane used in this study were similar to our previous report [16]. The reactor contained four anaerobic baffled stages with active volume of 6.26 L (8 L of volume) for each one. The last stage with active volume of 9.40 L (11.50 L of volume) was used as anaerobic/aerobic membrane bioreactor (Fig. 1). There were 5 operational cycles, for the first 3 cycles, two of membrane modules with area of 0.27 m² were inset in stage 5 for dead-end filtration and the membrane area was increased to 0.51 m² for the last two cycles. The carbon felt was used as the anode and air cathode (each piece with area of 110 cm² (10 cm × 11 cm)) material of sediment MFC and the titanium wire was used as the holder of electrodes. The air cathode carbon felt was immersed in PVDF casting solution with the formula of 12 g PVDF (Solvay, France), 100 g *N,N*-dimethyl acetamide and 6 g polyvinylpyrrolidone (K. 30) to form the air diffusion layer and inhibit the formation of biofilm [19]. The data acquisition system connected to computer was used to record potential. The saturated calomel electrode was worked as reference electrode.

The brewery wastewater was taken from the Hans brewery (Xi'an, China) for influent and the properties were shown in Table S1. The wastewater was injected in the reactor and crossed the anode filler upward for pollutants removal and power generation in the anaerobic baffled process (stage 1–4), and then the supernatant flowed into stage 5 as influent of anaerobic/aerobic membrane bioreactor (Fig. 1).

The water quality parameters of influent, supernatant of each stages and membrane effluent were measured every one week according to the standard methods [20]. The pH, turbidity and UV₂₅₄ were measured by pH meter (PHS-3C, INESA, China), turbidity meter (GDS-3B, KEDA, China) and ultraviolet-visible spectrophotometer (UV 2102C, UNIC), respectively. All of the water samples were filtrated via qualitative filter paper before testing excepted for turbidity testing. The soluble microbial products and extracellular polymeric substances (SMP and EPS) in supernatant and filter cake of different stages were extracted according to the

Download English Version:

<https://daneshyari.com/en/article/4752041>

Download Persian Version:

<https://daneshyari.com/article/4752041>

[Daneshyari.com](https://daneshyari.com)